



## INFORMATION BULLETIN - No. 07

### MOULD IN THE INDOOR ENVIRONMENT

#### Introduction

When we think of mould we usually think of “that black stuff” between the tiles in the bathroom. But what is mould really?

Mould is a group of organisms from the fungus kingdom which consists of large organisms like mushrooms and toadstools as well as moulds and yeasts which may be small or microscopic.

Many fungi are edible and make up a part of our normal diet. Mushrooms are an obvious example and truffles are considered a delicacy. Yeasts are used in food production such as in bread, cheese and beer. Some fungi are even used in making medicine, penicillin being probably the most famous example.

But there are many types of fungi that are harmful to human health or even deadly. Many mushrooms and toadstools are poisonous, including the aptly named *Angel of Death* mushroom. Moulds too can be harmful and produce toxins, cause disease or trigger allergic reactions.

In general, fungi grow in moist or wet areas where there is some form of nutrient present such as dirt, plant or animal matter. Dark areas away from direct sunlight are preferred. Most fungi produce spores (roughly equivalent to plant seeds) to reproduce and proliferate. Spores are quite small, measuring only a few micrometers in diameter (less than a tenth of the thickness of a human hair).

Visible fungus that does not grow in any particular shape is usually termed “mould”. It may look like small black spots, large discoloured or multi-coloured areas, or even a fluffy “carpet”.

#### Health Effects

Exposure to moulds can have a wide variety of health effects in people. These may be minor allergic reactions such as sore eyes or nasal congestion. More severe symptoms include: shortness of breath, sore throat, coughing, headache, rashes and dermatitis, upper respiratory complaints and asthma attacks. These can be quite serious and even fatal.

There are three main mechanisms by which moulds and other fungi can affect health.

*Allergy* : About 90% of moulds produce spores. These spores can cause allergic reactions in some people. Obviously some species of mould produce spores that are more allergenic than others and different people have varying reactions. Increased exposure may sensitise people so that they react to much lower levels. Even dead spores can cause reactions.

*Toxins* : Moulds produce toxins as a natural defence against competitors and predators. These toxins are known as mycotoxins and some are among the most poisonous substances known. Exposure to large amounts of mycotoxins can have serious health effects and may even be fatal. A classic example would be eating a poisonous mushroom but this is by no means the only mechanism. Some moulds even release mycotoxins into the air.

*Infection* : Much as bacteria and viruses can cause infections, so too can some types of mould and other fungi. In some cases this is “opportunistic” infection where the individual is immunocompromised in some manner. However there are fungi that are true pathogens (disease-causing agents). Infections of the lungs, skin, nails, ears, eyes and other areas are common.

## Types of Mould and Other Micro-Organisms

Type	Potential Health Effects	Comments
<b>Mould</b>		
Alternaria	May cause allergic reactions. A common trigger of asthma attacks in asthmatics. It has been associated with hypersensitivity pneumonitis, sinusitis, dermatomycosis and invasive infection.	Extremely widespread and ubiquitous. Outdoors it may be isolated from samples of soil, seeds, and plants. It is often found in carpets, textiles and on horizontal surfaces in building interiors.
Aspergillus	May cause allergic reactions. Some species may cause serious lung infections as well as infections of the skin, ears and eyes.	Common on decaying vegetation, soils, stored food and feed products in tropical and subtropical regions.
Cladosporium	A common allergen. Common cause of extrinsic asthma. Acute symptoms include oedema and bronchospasms, chronic cases may develop pulmonary emphysema.	Most commonly identified outdoor fungus. Commonly found on the internal surfaces of air handling systems. It is found on dead plants, woody plants, food, straw, soil, paint and textiles.
Epicoccum	A common allergen.	Found in plants, soil, grains, textiles and paper products.
Fusarium	May cause allergic reactions. Frequently involved in eye, skin and nail infections. Several species can produce potent toxins that affect the circulatory, alimentary, skin and nervous systems.	A common soil fungus. It is found on a wide range of plants. It is often found in humidifiers.
Mucor	Generally relatively harmless but may trigger allergic reactions in some people. Can cause infections in immunocompromised individuals.	Often found in soil, dead plant material, horse dung, fruits and fruit juice. It is also found in leather, meat, dairy products, animal hair and jute.
Penicillium	It may cause hypersensitivity pneumonitis and allergic alveolitis in susceptible individuals. May cause allergic reactions and trigger asthma attacks.	Often found in aerosol samples. Commonly found in soil, food, cellulose and grains. It is also found in paint and compost piles as well as carpet, wallpaper and in fibreglass duct insulation.
Stachybotrys	Several strains of this fungus may produce a mycotoxin which is poisonous by inhalation. People exposed to this toxin may experience cold and flu symptoms, sore throats, diarrhoea, headaches, fatigue, dermatitis, intermittent local hair loss and generalized malaise. Also suppresses the immune system.	This dark coloured fungi grows on building material with a high cellulose content and a low nitrogen content. Areas with relative humidity above 55% and subject to temperature fluctuations are ideal for toxin production. Often difficult to find in indoor air unless disturbed.
Trichophyton	Can cause ring worm, athlete's foot, skin, nail, beard, and scalp infections.	Found on soil and skin.

Type	Potential Health Effects	Comments
<b>Yeast</b>		
Candida	Common cause of superficial infection, oral and vaginal infection, sepsis and disseminated disease. Also causes thrush and other diseases. May cause allergic reactions.	Found in animals and in man. Has been isolated from the skin and mucosa of man, but has also been recovered from leaves, flowers, water, and soil. Considered to be a normal component of the flora of mouth and other mucous membranes in the body.
Rhodotorula	May cause allergic reactions. Has been known to cause infections.	A reddish yeast typically found in moist environments such as carpeting, air-conditioning cooling coils and condensate trays.
<b>Bacteria</b>		
Aeromonas	Potentially harmful. May cause infections.	Commonly found in indoor air.
Bacillus	Most species are relatively harmless dust organisms. Some species are known to cause disease.	Very common in indoor environments.
Legionella	Causative agent of Legionnaires Disease, a serious and often fatal type of pneumonia. Also causes the less serious Pontiac Fever.	Found in water reservoirs, creeks, dams and other bodies of water. Commonly found in building water such as cooling towers, spa pools, humidifiers, showers, etc. Also found in soils and potting mix.
Micrococcus	A relatively harmless dust organism.	Common in areas of human activity. High levels may indicate poor ventilation.
Pseudomonas	Potentially harmful. May cause infections.	Often present in water reservoirs.
Staphylococcus	Often found growing on skin. Some species are potentially harmful and can cause serious infections.	Common in areas of human activity.

### Recommended Standards

There are no recognised standards for total counts of airborne micro-organisms. This is because a simple number does not properly characterise the health effects of the wide variety of species that are commonly present. Also the airborne count can change rapidly and may increase greatly if, for example, spores are released.

Mould spores and other microbial materials are present in the outdoor air and the levels outdoors can also vary dramatically depending on factors such as the weather, climate, time of year, season and local activities.

However, if the total count indoors is less than about 750 colony forming units per cubic metre of air (<750 cfu/m<sup>3</sup>) and the numbers of potentially harmful species are relatively low then conditions are usually considered satisfactory. Indoor counts that are significantly higher than outdoor levels may indicate an indoor source or amplification site. Any significant indoor growth should be avoided and steps should be taken to eliminate obvious sources.

Similarly there are limited standards for microbial growth on surfaces. Some standards for clean rooms and other controlled environments do exist but these are not applicable to general indoor environments nor the internal surfaces of air handling systems.

Surface sampling is useful in identifying the types of organisms that are present. Also some semi-quantitative analysis is possible; very high levels may suggest a problem for example.

One standard that does apply is Australian Standard AS 3666 *Air handling and water systems of buildings – Microbial control*. This deals with aspects of design and maintenance to help prevent mould and other microbial growth within the air handling systems. An important requirement of this standard is regular inspections followed by cleaning where required.

### **Mould in Air Handling Systems**

Air handling systems in buildings provide a perfect environment for mould growth. The dirt and dust that tends to collect there provides nutrients, there is a source of water (for example, condensation on coils and other surfaces) and the temperatures are favourable. Consequently, in the absence of strict hygienic maintenance, mould can thrive and proliferate.

Obviously, visible mould growth is a sign of inadequate hygienic maintenance, but the problem may not always be visible. Until mould colonies become quite large they can be difficult to see or even invisible to the naked eye. Mould will also grow in hidden places such as between the fins of cooling coils or within insulation or filters.

Therefore a carefully implemented program of cleaning and sanitising the internal surfaces and components of the air handling systems should be in place in every building. The main focus of this should be the air handling units and any other areas where moisture may be present. The air ducts are not generally a source of problems unless they have become wet but should be inspected from time to time to ensure that they do not become excessively dirty. Return air and exhaust ducts are more likely to be a problem than the supply ducts.

The use of good quality air filters is an important step in keeping the systems clean and trapping mould spores. Regular filter maintenance is also necessary. The use of disposable media filters is of benefit since at the end of the filter's life it (and the dirt and spores it contains) are removed from the building entirely. Washable filters cannot be completely cleaned and the introduction of water (during washing) merely encourages mould growth.

### **Other Areas of Mould Growth in Buildings**

The main factor influencing mould growth is the presence of water. Wherever sufficient water is present there are usually enough nutrients to support the growth of mould spores that are invariably found in the indoor air. Water may be from leaks, floods, overflowing sinks, blocked drains, condensation on cold surfaces, etc.

Following water leaks or floods (such as may be caused by a burst pipe) mould growth in carpet and other building material can be explosive. As a consequence, airborne microbial counts can increase from less than 100 cfu/m<sup>3</sup> to many thousands of cfu/m<sup>3</sup> in a matter of hours.

Drying out the material may not solve the problem either. Many moulds release spores when the moisture dries up as part of their normal lifecycle and this dramatically increases the airborne counts. The dry mould can continue to be a problem too since dead mould is often still allergenic and the toxins produced by the fungi during its growth period are still present.

### **Legal Implications**

In Australia, occupational health and safety laws generally require that employers, building owners and building managers ensure the health, safety and welfare of employees and anyone else in a place of work, including visitors, employees of others, etc.

The NSW Occupational Health and Safety Regulation 2001 reads as follows (Section 9 Clause1):

**9 Employer to identify hazards**

(1) An employer must take reasonable care to identify any foreseeable hazard that may arise from the conduct of the employer's undertaking and that has the potential to harm the health or safety of:

- (a) any employee of the employer, or
  - (b) any other person legally at the employer's place of work,
- or both.

And Clause 2(h) specifically mentions identifying hazards arising from "biological organisms, products or substances".

In the United States, mould in buildings has become a huge issue. Over the past few years, a number of landmark legal decisions have resulted in multi-million dollar damages awards. The following are some significant examples:

*Ballard vs. Fire Insurance Exchange: over \$US 32 million - mould infestation of home caused by leaking pipe leading to illness of entire the family.*

*Martin County Courthouse, Texas: contractor ordered to pay \$US 11.5 million in damages and \$2.9 million in interest - infested with Aspergillus and Stachybotrys.*

*Anderson vs. Allstate Insurance: \$US 18.5 million to policy holder - mould in home.*

*Construction company told to pay motel owner \$US 6.7 million - defects leading to mould infestation*

*Thousands of other cases are under way.*

In some states in the USA it has become law that any mould problems in a building must be disclosed to any potential purchasers of the building.

Such legal cases have not yet eventuated in Australia but there is the potential for these to occur.

## **Identification and Remediation**

It is important for employers, building owners and managers to determine areas where mould might be a problem. This should be followed by proper identification and assessment of any risks.

This is even more critical in places where the occupants may be more susceptible than usual to the hazards of mould exposure. Wherever the elderly or the very young or those already in poor health are present, the utmost care should be taken to minimise the risks.

Remediation and clean up of any mould affected areas can be complicated and will not be successful unless the proper steps are taken. Appropriate biocides must be used and often materials such as carpet or insulation must be replaced entirely.

Preventative action should also be taken to minimise mould growth in the air handling systems and other parts of the building. Following the requirements of Australian Standard AS 3666 is an important step.

Expert advice should be sought to ensure that mould hazards are eliminated or controlled and to minimise risks. All care should be taken to protect the health and well-being of employees and other occupants of buildings.

*Disclaimer: Engineered Environments (IEQ) Pty Ltd does not offer legal or medical advice and nothing in this document should be construed as such. Readers should seek their own legal or medical advice on any matters that may relate to information contained herein.*

© Copyright Engineered Environments (IEQ) Pty Ltd, 2002